INTRODUCTION OF NEW WATER SOURCES TO BENDIGO – A BRIEF HISTORY OF THE WATER YOU SHOWERED IN THIS MORNING

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ABSTRACT

The Bendigo water treatment plant (WTP) is one of the three WTP's which form the AQUA 2000 contract between Veolia Water Australia (VWA) and Coliban Water, to supply safe and reliable drinking water to Bendigo, Castlemaine and Kyneton. Recent drought conditions in central Victoria have severely impacted upon Coliban Water's catchments and hence an alternative secure water supply has been needed for Bendigo. As a result alternate supplies such as the Waranga Basin have been drawn upon via the newly constructed Goldfields Super pipe. These new water sources have created a considerable variation in raw water quality compared to that for which the Bendigo WTP was originally designed to treat.

Initial assessment of the Waranga water quality entering the Sandhurst reservoir revealed variations in colour, turbidity, alkalinity, and metals concentration. In order to adapt to these changes we have considered a number of options for upgrading process elements, such as the lime dosing facility and implementing a greater capacity to manage increasing volumes of water treatment sludge. These variations have serious implications on our daily operations and contractual obligations to Coliban Water, including extra water sampling and analysis, higher chemical usage along with additional staffing resources to conduct process optimisation trials. This paper will provide an overview of the challenges faced by the introduction of new water sources to the Bendigo system along with the process investigation and optimisation implemented to meet these challenges.

KEY WORDS

Drought, New Water Sources, Water Treatment, Waranga Channel, Water Quality

1.0 INTRODUCTION

The Bendigo WTP is one of three Membrane Plants constructed as part of the Aqua 2000 Contract to Supply Bendigo, Castlemaine and Kyneton and surrounding areas. These WTP's are designed to deliver fully treated water with quality targets that exceed World Health Organization and Australian Drinking Water Guidelines and supply approximately 110,000 customers. The three plants are contracted to be operated by Veolia Water Australia under a 25 year BOOT (Build, Own, Operate, Transfer) Contract. When commissioned in mid 2002, the Bendigo WTP was the largest Submerged Continuous Micro Filtration Submerged (CMF-S) Plant in the world with a maximum capacity of 126ML/day

The period of drought, currently being experienced in various parts of Australia, is often referred to as the 'drought of the century,' or 'the most severe drought since Federation.' The severe impact of the drought on water storages has driven Coliban Water to explore options that will 'secure our water future' as part of their Waterplan 2055. A significant part of Coliban Water's Waterplan 2055 is the Goldfields Super pipe (Reference Coliban Water website (www.coliban.com.au) 2009).

The Super pipe was brought online in 2007 and supplies water both to Bendigo as well as Ballarat. Figure 1 shows a diagram of the new Goldfields Super pipe which supplies raw water to the Bendigo WTP via Sandhurst Reservoir.

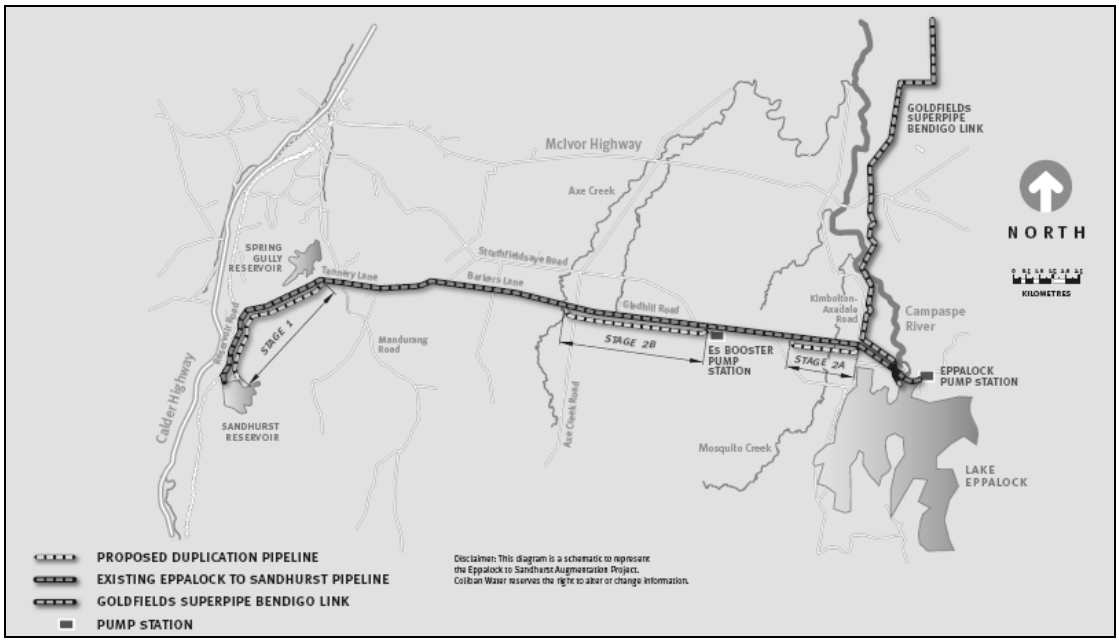

Figure 1: **The *Goldfields Super pipe, Lake Eppalock and Sandhurst reservoir.***

The Goldfields Super pipe transfers water from the Waranga channel to near Lake Eppalock, where it can either divert to the Eppalock-to-Bendigo pipeline or run into Lake Eppalock, a 312,000ML storage located near Bendigo (Figure 1). The preferred transfer option is to run straight into Sandhurst Reservoir via the Eppalock-to-Bendigo pipeline. The main reason for bypassing the Lake Eppalock storage is that at low levels Eppalock has water quality issues with regard to high manganese and bromide. By taking Eppalock offline, whilst storages are low, and supplying directly from Waranga channel, the risk of manganese and bromide entering the Bendigo WTP is reduced.

The Waranga channel is supplied by the Waranga basin, which is an "off-river" storage located between the Goulburn and Campaspe River basins, where water is diverted from the Goulburn River at the Goulburn Weir, via the Stuart Murray Canal and Cattanach Canal. The Basin has a catchment area with a capacity of 432,360 ML and is one of the largest storages in the Goulburn System (Reference Coliban Water website (www.coliban.com.au) 2009, Goulburn Murray Water website (www.g-mwater.com.au) 2009).

2.0 DISCUSSION

2.1 Bendigo WTP Process Overview

A number of treatment processes are involved in treating water at the Bendigo WTP to ensure reliable, high quality drinking water is supplied to the Bendigo region (see Figure 2). The ultimate requirement of this process is to provide potable water which exceeds contractual requirements of the client – Coliban Water.

Table 1: *Water quality data for Sandhurst, Coliban channel and Waranga channel*

Parameter	Average (Maximum)	
	Coliban Main Channel	Waranga Channel
Turbidity (NTU)	3.24 (11.6)	19.6 (45.8)
True Colour (HU)	17.2 (55.0)	50.5 (183)
Iron (mg/L)	0.25 (0.5)	0.34 (1.4)
Manganese (mg/L)	0.11 (0.16)	0.04 (0.05)
Alkalinity (mg/L)	49.6 (96.2)	19.7 (22.4)
Bromide (mg/L)	0.26 (0.66)	0.04 (0.05)

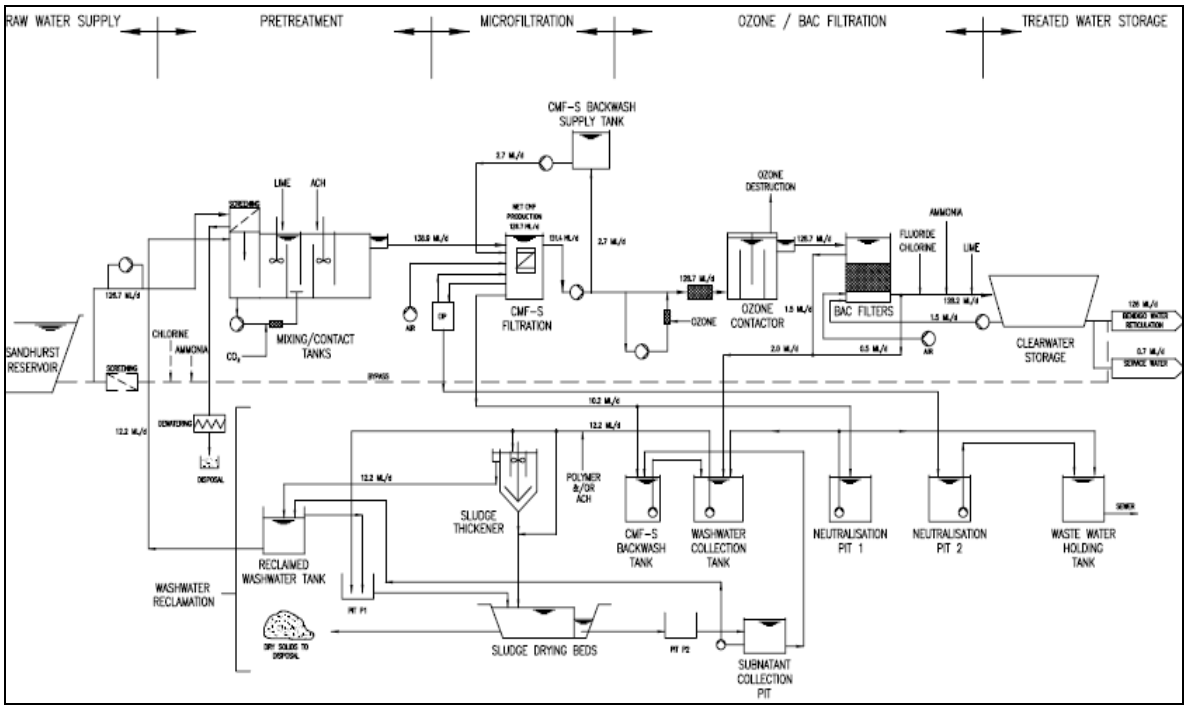

Figure 2: *Overview of the Bendigo WTP treatment process.*

The major processes incorporated in the Bendigo WTP include the following:

- Raw water transfer system
- Pre-treatment system (Coagulant dosing, alkalinity and pH correction)
- Submerged Continuous Micro filtration (CMF-S)
- Ozone/Biological Activated Carbon (BAC) filtration (disinfection, taste and odour)
- Fluoridation & Chloramination
- Post-lime dosing (pH correction)
- Bulk Chemical Supply
- Treated Water Storage
- Wash water Treatment and Handling (Coagulant dosing, sludge thickening and sludge dewatering/drying).

2.2 Bendigo WTP; Process Verification with Waranga Water

A CMF-S process verification plant (PVP) was set up at the Rochester WTP to determine the impact of the new source water on treatment at Bendigo (Figure 3). Rochester was chosen for the location of the PVP due to its accessibility to Waranga channel water and was accessed with the cooperation of Campaspe Asset Management Services.

The PVP was run for a period of 5 weeks and identified a number of significant differences in water quality. Specifically the parameters of alkalinity and turbidity in relation to our raw water contractual limits and design capabilities of the Bendigo plant. Table 1 shows that the alkalinity and turbidity in the Waranga water is significantly different to the water quality limits in the Coliban channel (Table 1). Hence a number of changes are required at Bendigo WTP in order to successfully treat the new raw water source. The changes recommended as a result of the pilot plant trial were:

- Sludge drying lagoons at Bendigo are under-sized for treating the expected raw water at the maximum expected treatment production volumes.
- The investigation found that the pre-lime and post-lime transfer pumps are under-sized to deliver the expected maximum dose rates for all treated water production rates.
- The results of the trial suggested that the maximum expected CO_2 dose rates exceed installed design limits.

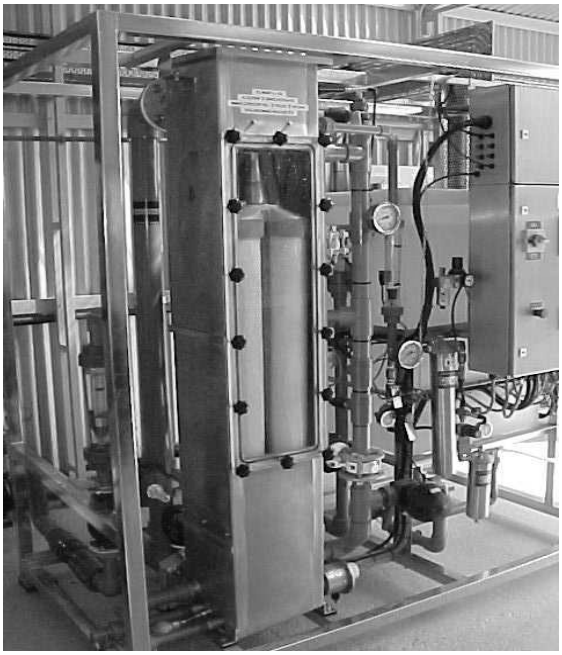

Figure 3: ***The PVP used to test the effect of Waranga water on Membrane filtration***

2.3 Effect of Waranga Water on the Bendigo Process

The results of the PVP at Rochester have been confirmed by our operating experience treating Waranga water at Bendigo WTP over the past 18 months. The most significant effects on our operations have been the dramatic increase in chemical usage, the

availability of sufficient sludge handling facilities and the exposure to Eppalock water quality issues, given that Eppalock may be used as a storage for Waranga water.
Lime and carbon dioxide consumption have been increased considerably due to the drop in raw water alkalinity (see Table 1) and the need to boost the alkalinity to our contractual limit of 50mg$CaCO_3$/L. Figure 4 details the change in the use of pre-treatment chemicals, bearing in mind that the first water from Waranga was September 2007. Overall Chemical delivery frequency for lime and carbon dioxide has increased by an average of 30%. A number of chemical dosing systems within the plant have required an upgrade to deal with the Waranga water, such as the Pre and Post lime dosing pumps, associated motors, hosing and fittings. SCADA systems have also been altered to reflect higher dose rate capacities of upgraded equipment

Significant steps have been taken by the operators to manage the risks of the new supply, some of which include optimising the sludge thickener to ensure maximum solids throughput by scrutinising sludge draw off, greater emphasis on lead times for procurement of process chemicals, more frequent backwash and chemical clean in place (CIP) to alleviate higher resistances through the membranes and additional sampling and lab testing.

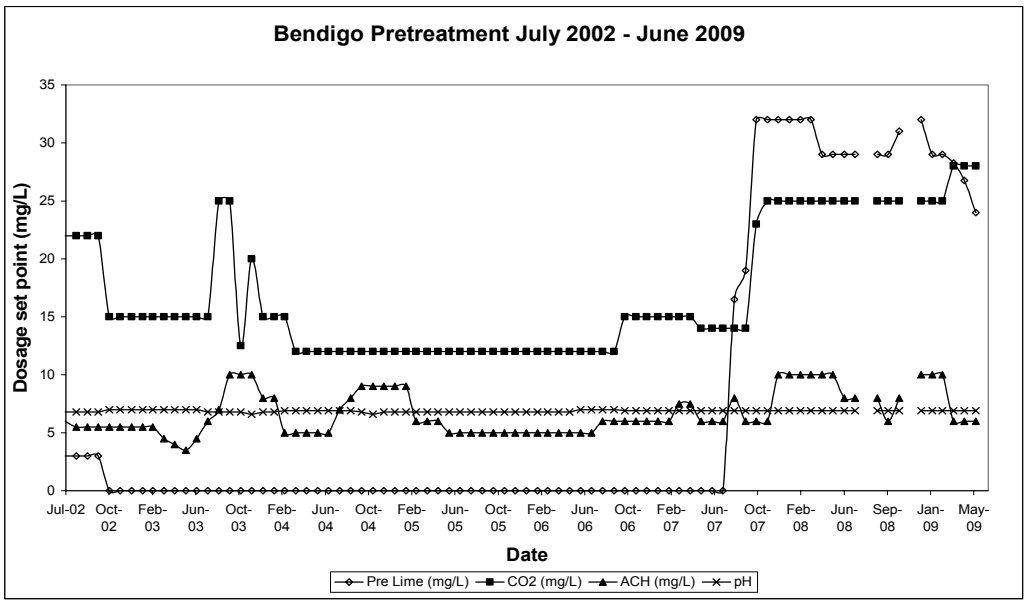

Figure 4: ***The change in pre-treatment chemical consumption at Bendigo WTP before and after the switch to Waranga source water.***

Due to an increase in turbidity in the Waranga water the sludge handling capacity at Bendigo has been put under pressure at high process flows. Since the switch to Waranga water in 2007 the solids loading on the Bendigo sludge system has experienced a three to four fold increase at similar process flows.

2.4 Process Upgrade at Bendigo WTP

A major project is currently underway to investigate upgrades to the Bendigo WTP to enable it to treat Waranga water at full plant design flows of 126 ML/d. This upgrade will allow Coliban Water to provide better water security to its customers during the summer peak demand period. For example the extra load on the sludge handling system has led to

ongoing investigations regarding the options of mechanical dewatering, constructing additional sludge drying beds or a hybrid of the two.

Due to the possibility of Waranga channel water being diverted into Lake Eppalock and then transferred from Eppalock to Sandhurst Reservoir, necessary steps need to be taken to mitigate Eppalock water quality issues, such as the aforementioned manganese and bromide issues. Current investigations indicate a potassium permanganate dosing system will be the most effective means of oxidising manganese and precipitating it out of solution. This however poses problems for our micro filtration membranes which are highly sensitive to strong oxidants. Hence the plan for upgrading the plant for manganese treatment will be twofold. Initially permanganate dosing will be implemented at the inlet to Sandhurst reservoir to prevent contact of the oxidising agent with the micro filtration membranes. Secondly a potential project to replace the current polypropylene membranes with oxidant-resistant PVdF membranes will be investigated, including a new permanganate dosing system installed at the head of the treatment plant.

3.0 CONCLUSIONS

From an operator's perspective, the most noticeable differences between Coliban system water and Waranga water are the difference in raw water turbidity and the increased chemical required to raise the alkalinity to meet contractual obligations, as well as the availability of adequate sludge handling facilities. Upgrades to the Bendigo WTP are currently being considered with a view to preparing the plant for treatment of Waranga water at increased flow rates. Potassium permanganate solutions are being investigated in order to mitigate any manganese issues associated with drought and water quality issues associated with Waranga water coming into contact with Eppalock water, should it be pumped to Sandhurst via the Lake Eppalock storage.

4.0 ACKNOWLEDGEMENTS

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